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Dated: 04-22-04 Signature: _____
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR U.S. LETTERS PATENT

Title:

CURTAIN WALL SYSTEM WITH ENHANCED RESISTANCE TO BLAST FORCES

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CURTAIN WALL SYSTEM WITH ENHANCED RESISTANCE TO BLAST FORCES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from, and incorporates by reference for any purpose the entire disclosure of, U.S. Provisional Application Serial No. 60/465,253 filed April 24, 2003.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0002] The present invention relates to curtain walls used for building exteriors and, more particularly, but not by way of limitation, to methods of and apparatus for constructing and assembling curtain walls with improved resistance to hurricane and blast forces.

HISTORY OF THE RELATED ART

[0003] The use of curtain walls for building construction is wide-spread and generally accepted by municipal building standards. They are cost effective and often aesthetically appealing. Curtain walls are typically constructed of extruded aluminum frame support members having generally U-shaped channels (although other shapes may apply) for supporting a plurality of panel members that serve as the exterior of a building. Such panel members are most often panes of glass, and often double pane glass sections, but other paneled building materials such as aluminum, granite, slate, or concrete are also utilized. Such panel members are often of identical size and shape. However, near doors, opening windows, or other access points into the building, panel members of different sizes and shapes may be utilized.

[0004] More specifically, such curtain walls generally include multiple vertical and horizontal members, or mullions. In some instances, the curtain wall system includes a plurality

of horizontal sill members having at least one portion forming an upwardly facing region (or channel) at the bottom of a wall section. The curtain wall systems also include horizontal head members having a downwardly facing channel at the top of a wall section, and a plurality of vertical mullions running between the sill member and head members. Panel members are then generally supported by the channels of the sill member and the head member. Vertical joints between adjacent panel members are formed at the mullions. In some designs, the mullions are disposed interiorly of the sill member, the head member, and the panel members so that only the joint between adjacent panel members, and not the mullions themselves, are visible from the exterior of the building. The designs do, however, vary, depending upon the desired aesthetics of the curtain wall construction, and the architecture involved therewith. One such design is set forth and shown in U.S. Patent No. 4,899,508, assigned to the assignee of the present invention.

[0005] In another curtain wall construction, multiple panel members are typically arranged side-by-side and are secured and sealed between a sill member and a head member, with their vertical joints overlapping at a mullion. This vertical joint must then be sealed from both the interior and exterior of the building using both resilient gaskets, sealant tapes, sealant, and/or structural silicone, as described for reference purposes below.

[0006] Referring now to FIG. 1, a schematic, cross-sectional view of a sill member 10 of an exemplary curtain wall is shown. The sill member 10 secures a curtain wall to a structural support surface such as a concrete slab 12. The concrete slab 12 of this illustration may be disposed at ground level it may comprise one of a plurality of floor surfaces of a high rise building or, in some embodiments, positioned behind/within the curtain wall system. In such designs, the sill member 10 may simply be a horizontal member secured to the vertical mullion. Although not shown in FIG. 1, a head member similar to the sill member 10 secures the curtain wall to a concrete slab between floors of a building or other building structures, and a

plurality of mullions span between the sill member 10 and the head member. The sill member 10 is typically formed as an integral aluminum extrusion. The sill member 10 also generally includes a channel section 14, an anchoring section 16 disposed interiorly of a channel section 14, and a cover 18.

[0007] Still referring to FIG. 1, the channel section 14 and the cover 18 cooperate to secure the panel member 20 to the sill member 10. More specifically, the channel section 14 includes a base 14a and two legs 14b and 14c that form a upwardly facing U-shaped channel. A support member 22 rests on the top surface of the base 14a. The exterior leg 14b has a groove 24 proximate the upper end of its interior surface facing the panel member 20, and the interior leg 14c has a support surface 26 proximate the upper end of its interior surface. The cover 18 has a downward projecting leg 28 that engages a groove 30 on the exterior surface of the interior leg 14c. The cover 18 also has two tongues 32, 49, one proximate to each end of the cover 18. The panel member 20 is placed within the channel section 14 on an upper surface of a setting block 34. An exterior and interior gasket 36, 38 are located at the upper end of the exterior and interior legs 14b, 14c. The gaskets 36, 38 operate to hold the panel member 20 in the channel section 14. The setting block 34 is disposed on the top surface of the support member 22. The exterior gasket 36 has a tongue 36a that engages the groove 24 of the exterior leg 14b. The exterior gasket 36 is typically pre-installed in groove 24 of the exterior leg 14b during the manufacture of the sill member 10. The interior gasket 38 has a groove 38a that engages the tongue 32 of the cover 18 and the support surface 26 of the interior leg 14c. The channel section 14 further includes a plurality of support legs 40 below base 14a.

[0008] The anchoring section 16 includes a base 16a, an interior leg 16b, and a plurality of support legs 42 below the base 16a. The base 16a has a plurality of holes 44 spaced along its length for receiving fasteners 46 to secure the sill member 10 to the concrete slab 12.

The interior leg 16b has a groove 48 for receiving the tongue 49 of the cover 18. The cover 18 stabilizes the interior gasket 38 that presses against the panel member 20 and also conceals the base 16a of the anchoring section 16 so that the fasteners 46 are not visible.

[0009] The following technique is typically used to install the panel member 20 of such a curtain wall. The sill member 10 is laid on a shim 56 in the proper position on the concrete slab 12 and is used as a template to drill holes into the concrete slab 12 for each fastener 46. One should note that the shim 56 does not run continuously along the length of the sill member 10. Instead, the shim 56 is used at low points of the concrete slab 12 to level the sill member 10, if necessary. The sill member 10 is removed from the shim 56, and a hole 50 with a larger diameter is drilled in the place of each of the holes drilled using the sill member 10. A structural insert 52 is secured within each of the holes 50 via epoxy or other conventional means. Each insert 52 has an internally threaded hole 54 for receiving fasteners 46. The sill member 10 is repositioned on the shim 56 and secured to the concrete slab 12 using fasteners 46. A sealant 58 is disposed continuously on the concrete slab 12 along both the exterior and interior sides of the shim 56. A head member similar to the sill member 10 is secured to part of the building structure using the above-described techniques. Vertical mullions are secured between the sill member 10 and the head member at appropriate intervals along the curtain wall. The vertical mullions are attached at each side to sill members 10. The support member 22 is disposed on the base 14a of the sill member 10, and the setting block 34 is disposed on the support member 22. The panel member 20 is then installed from the exterior of the building, typically first being tilted into the channel section of the head member, and then being dropped into the channel section 14 of the sill member 10. The cover 18 is installed in the sill member 10, and a glazing stop is installed in the head member of the curtain wall. The interior gasket 38 is disposed on

the tongue 32 of the cover 18 of the sill member 10, and a similar gasket is disposed on the tongue of the glazing stop of the head member.

[0010] Of course, multiple panel members 20 are typically arranged side-by-side and are secured and sealed between the sill member 10 and the head member in this manner, with their vertical joint overlapping at a mullion. This vertical joint must then be sealed from both the interior and exterior of the building using both resilient gaskets and/or structural silicon.

[0011] While such curtain walls, and other conventional curtain walls, have proved to be reliable commercial building systems, other design parameters have relatively recently been brought into focus. For example, the ability of a curtain wall system to withstand impact from strong forces, such as hurricane force winds or an unexpected blast, is under study. To affect such parameters, the curtain wall system must be able to absorb the energy of a blast or hurricane force loads and secure the panel members placed thereon. In this manner the curtain wall system prevents the panel members, often glass, from being blown into the interior of the building causing additional destruction and injury. Relative to the design aspects of the present invention, an example of a storm-resistant window is set forth and shown in U.S. Patent No. 5,560,149. In this particular system, a storm-resistant window includes a window frame and a window sash for preferably aluminum extruded frame members, a glass and polymer safety glass, clamping glazing beads that bear sealingly on the glass, and a sash locking clasp arrangement. The window is said to resist impact characteristic of windblown hurricane debris, for example, and resilient enough to damp wind loads induced by 75 mph (120 kph) winds, with resilient arching and twisting of the frame members. Such focus upon the window construction further manifests the interest of the building industry to create a curtain wall system accommodating the forces generated by hurricane force winds and/or unexpected blasts.

Various types of glass, such as safety glass, laminated glass, etc., may be utilizes to form curtain walls for buildings.

[0012] The current use of structural silicone to seal glass panel members into a curtain wall system typically specifies a bonding agent thickness of 3/8" to 5/8". Although normally successful for conventional loads, in accordance with embodiments of the present invention this thickness is increased to withstand blast impact loading. When increasing the amount of bonding agent utilized in the curtain wall, an additional surface may be added within the curtain wall system to accommodate the additional bonding agent.

SUMMARY OF THE INVENTION

[0013] The present invention relates to curtain walls used for building exteriors and the assembly of a building curtain wall with improved blast resistance. More particularly, one aspect of the present invention relates to a curtain wall system including at least one vertical mullion formed with a channel having a depth sufficiently increased for securing a panel member therein for enhanced resistance to a blast force. The system also includes at least one horizontal mullion formed with a channel for receiving the panel member. The channel of the horizontal mullion is formed of an increased depth for enhanced resistance to a blast force.

[0014] In another aspect, the present invention relates to a vertical mullion for forming a curtain wall. The vertical mullion includes at least one channel for receiving a panel member. The channel includes a first side member of an increased length for receiving an increased portion of the panel member, a base member for receiving a base portion of the panel member, and a second member of an increased length for receiving an increased portion of the panel member.

[0015] In yet another aspect, the present invention relates to a horizontal mullion for forming a curtain wall. The horizontal mullion includes a channel for receiving a panel

member. The channel includes a first side member of an increased length for receiving an increased portion of the panel member, a base member for receiving a base portion of the panel member, and a second member of an increased length for receiving an increased portion of the panel member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] For a more complete understanding of the present invention, and for further objects and advantages thereof, reference is made to the following description taken in conjunction with the accompanying drawings in which:

[0017] FIG. 1 is a schematic, cross-sectional view of conventional curtain wall construction;

[0018] FIG. 2 is a cross-sectional view of a horizontal sill member incorporating the principles of the present invention and having a channel of increased depth adopted from facilitating the application of increased bonding agent between the panel member and the horizontal mullion;

[0019] FIG. 3 is a cross-sectional view of a vertical mullion of an alternative embodiment of a curtain wall system having a channel of increased depth in accordance with the principles of the present invention;

[0020] FIG. 4 is a cross-sectional view of a vertical mullion of a curtain wall system having panel members mounted therein in accordance with the principles of the present invention;

[0021] FIG. 5 is a cross-sectional view of a vertical mullion of an alternative embodiment of a curtain wall system incorporating the principles of the present invention and illustrating the increased uses of silicon therewith; and

[0022] FIG. 6 is a cross-sectional view of a head member incorporating the principles of the present invention and having a channel of increased depth adopted from facilitating the application of increased bonding agent between the panel member and the head member.

DETAILED DESCRIPTION OF THE INVENTION

[0023] It has been discovered that a number of advantages can be obtained by assembling a curtain wall system with the use of an increased amount of bonding agent for retaining a panel member therein. This increase in the amount of bonding agent can result in an improvement in the securement of the panel members within the curtain wall system and thus the structural capability thereof. Panel members mounted in a channel having a relatively small bonding surface area will manifest less adherence and structural interconnection with the horizontal and vertical mullions extending therearound than those panel members mounted in a channel of increased depth as set forth as shown in the present invention. For example, in some embodiments, the depth of the channel may be substantially on the order of one inch or more. In some embodiments, a system is created with minimal sight line width and maximum bonding surfaces with no exposed fasteners.

[0024] Referring to Figures 2-6 there are shown multiple views of curtain wall system 200 having panel members 202 secured or mountable therein. In Figures 2-4, the panel members 202 are shown positioned within a channel 204 of a horizontal sill member 206 and channels 300 of a vertical mullion 302. The vertical mullion 302 may be formed of several pieces or formed as one integral piece. It may be seen that the channels 204, 300 are of increased depth for facilitating receipt of a bonding agent 208, such as silicone, therein and the adherence of a panel member 202 thereto.

[0025] The utilization of panel members 202 formed of glass having increased structural integrity may not necessitate the use of enlarged channels 204, 300 in accordance with the principles of the present invention because such certain types of reinforced glass have sufficient structural stiffness. Less expensive glass, may bow under hurricane force winds and/or related blast forces, which may place the bonding agent in a sheer force failure mode relative to the surrounding vertical mullions 302 and horizontal mullions 206. With the utilization of less expensive, more flexible, glass panel members 202, it has been noted that the use of the increased quantity of the bonding agent 208, such as silicone, and in conjunction with the increased depth of the channels 204 300 as shown in the figures herein will provide an improved blast resistance.

[0026] The channel 204 of the horizontal sill member 206 includes a first side member 204A, a base member 204B, and a second side member 204C. The base member 204B is sufficiently deep in the channel 204 to increase the amount of the panel member 202 that resides in the channel 204. By increasing the depth of the base member 204B, an increased amount of the second side member 204C is in contact with the bonding agent 208 and the panel member 202.

[0027] In a similar manner, the channel 300 of the vertical mullions 302 has an increased depth to accommodate blast forces. Each channel 300 includes a first side member 300A, a base member 300B, and a second side member 300C. The first and second side members 300A, 300C are of an increased length in order to increase the depth of the channel 300. The increased depth of the channel 300 allows a larger portion of the panel member 202 to reside in the channel 300. In addition, the increased depth allows an increased portion of sealant 304 to be placed between the panel member and the second side member 300C.

[0028] Referring now to Figure 5, an alternate embodiment of the vertical mullions 302 of the curtain wall system 200 is illustrated. As opposed to forming a vertical mullion 302 with a channel 300 near an edge of the vertical mullion 302, in the alternate embodiment, the channel 300 is formed substantially near the center of the vertical mullion 302. Again, the channel 300 is of an increased depth for increasing the surface area of the panel member 202 that is in contact with the bonding agent 208. Although the vertical mullions 302 shown herein are illustrated as having a particular configuration, any configuration of vertical or horizontal mullion may be formed with a channel with an increased depth in accordance with embodiments of the present invention.

[0029] Figure 6 illustrates a cross-sectional view of a head member 206a in accordance with an embodiment of the present invention. The head member 206a is similar in structure to the horizontal sill member 206 of Figure 2. The head member 206a receives a top portion of the panel member 202 in a channel 204 of an increased depth and sealant 304 may be placed therein for sealing the channel 204 and the panel member 202.

[0030] It may thus be seen that a curtain wall system could thus be constructed in accordance with the principles of the present invention to provide the structural integrity to withstand certain forces such as hurricane winds and/or impacts and/or blast impacts of select characteristics to be certain design criteria and/or construction regulations/municipal code restrictions in an economically viable manner.

[0031] It is thus believed that the operation and construction of the present invention will be apparent from the foregoing description. While the method and apparatus shown or described have been characterized as being preferred it will be obvious that various changes and modifications may be made therein without departing from the spirit and scope of the invention.